DOCUMENT RESUME

ED 284 449 FL 016 855

AUTHOR Pederson, Kathleen Marshall
TITLE Research on CALL.
PUB DATE 82
NOTE 34p.; In: Smith, William Flint, Ed. Modern Media in Foreign Language Education: Theory and Implementation. The ACTFL Foreign Language Education Series; see FL 016 850.
PUB TYPE Information Analyses (070)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Computer Assisted Instruction; *Educational Research; *Educational Technology; Evaluation Criteria; Language Laboratories; *Research and Development; *Research Design; Research Methodology; *Second Language Instruction; Theory Practice Relationship

ABSTRACT

The status of research on computer-assisted language learning (CALL) is explored beginning with a historical perspective of research on the language laboratory, followed by analyses of applied research on CALL. A theoretical base is provided to illustrate the need for more basic research on CALL that considers computer capabilities, learner differences, and learning tasks in concert. Basic research in CALL is also evaluated. CALL research must be conducted vigorously with the research design taking into account several factors specific to each research study. This paper concludes by stating that research design chosen for these studies should take into account the following factors: (1) the research should be cost effective; (2) the argument that comparative research that attempts to illustrate the superiority of computers over other mediums for delivering language instruction should forever be abandoned; and (3) encouragement should be given to evaluative research using CALL software that may be widely adopted and may enjoy an extended use over time. (CB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MIC..OFICHE ONLY HAS BEEN GRANTED BY

L. Fiddle

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ED284449

Research on CALL

Kathleen Marshall Pederson
Buffalo Grove High School, Buffalo Grove, Illinois

Introduction

The question most commonly asked about computer-assisted language learning (CALL) by language teachers is no longer "Are you using CALL?" but "What kind of CALL do you use?" Assumptions about the value and the potential of the computer as a teaching tool abound. In fact, both Ragsdale (62) and Hurly and Hlynka (34) have argued that blind faith in the power of the computer has strongly shaped current American educational practices. The momentum toward the electronic classroom is so swift and so powerful that many second-language educators echo Teichert's (87) assertion that becoming computer literate and incorporating CALL into the curriculum is a matter of professional survival.

Although it could be argued that Teichert's dilemma is perhaps too extreme to characterize the profession at large, his sense of urgency about incorporating CALL into the curriculum portrays accurately the thinking of a growing number of language teachers who, in general, reflect a new enthusiasm for technology-aided language learning. Seemingly innumerable testimonials to the observed learning benefits and the yet untapped potentials of CALL are commonplace. Alatis (3) reminds the profession that if it wishes to take the humanistic value of second-language study seriously, then it must not shy from technological learning aids, but should explore all possibilities. In all fairness, this penchant for embracing innovation is one of the profession's most admirable qualities. When,

Kathleen Marshall Pederson (Ph.D., The Ohio State University), former Assistant Professor of French and Chair of Languages and Literature at Northwestern College (Orange City, IA), is currently a teacher of French and Spanish at Buffalo Grove High School in Buffalo Grove, IL. The 1986 recipient of the Emma Marie Birkmaier Award for Doctoral Dissertation Research in Foreign Language Education, she is a member of ACTFL, AATF, and CALICO.

FL016855

BEST COPY AVAILABLE

however, testimonials are permitted to sway important curricular decisions without corresponding research evidence, enthusiasm becomes a serious flaw.

Consider, for example, a typical and seemingly simple endeavor such as designing a CALL program for practicing the differences between the Spanish preterite and the imperfect. The instructional designer is faced with an array of ways the computer can deliver instruction and must decide, among other possibilities, how and when to use graphics, sound, feedback, branching from one learning task to the next based on learner response or request for new material, and how to display all these coding options accurately and efficiently. Simply stated, the CALL instructional designer is too often forced to make decisions that affect courseware design and content without the benefit of adequate research results that generalize to language learning contexts when the various coding options available in computer-assisted instruction are utilized in specific ways.

Stern (84) observes that "the teaching of language is often regarded more as a matter of practical intuition, inventiveness, and sensitivity than as a suitable subject for research" (p. 53). He and others, however, are quick to remind the profession of the seriousness of its last technological blunder, the blind trust given the language laboratory's projected impact on learning in the early 60s. Nevertheless, the careful instructional designer searches controlled research in vain for guidance on CALL. Simply stated, there is little information about how to use the computer's capabilities to enhance CALL lesson delivery (Hope, Taylor, and Pusack, 29; Meredith, 49; Underwood, 89).

Not only has little research been conducted on how to use the computer's coding options to improve learning, the numerous studies that have questioned whether computers do make a difference in achievement have shown, generally, that "there are no learning benefits to be gained from employing any specific medium to deliver instruction" (Clark, 12, p. 445). In short, findings showing no significant differences have prevailed in spite of utopian projections to the contrary (Schramm, 74; Salomon, 68). Recent CALL research, however, suggests that the *design* of computer software to cause adjustments in cognitive processing, not the *medium* used to deliver instruction, stands the best chance of affecting learning outcomes. Only recently a few CALL studies have been conducted that illustrate that certain learning tasks for certain learners can be facilitated by the use of CALL (Pederson, 59; Robinson et al., 64). In other words, compelling evidence is beginning to emerge that CALL is highly context-bound and must, therefore, take such variables as learner differences, learning task, and the computer's coding options into account.

While no success has resulted from attempts to demonstrate that computer-assisted instruction is more effective than some other mode of instruction, these results should not be surprising. In the past two decades,

foreign language educators have become increasingly aware of the fruitless nature of what have been coined "broad methodologies comparisons" (Smith and Berger, 78; Scherer and Wertheimer, 73). Comparative research that endeavors to identify a superior medium or a superior method is doomed to provide murky and usually uninterpretable results because the essential variables that might make a difference in a given language-learning context cannot be isolated, manipulated, and examined adequately.

Generally speaking, appropriate and feasible research in computer-assisted instruction (CAI) has lagged far behind vigorous materials development, especially in the area of CALL (Meredith, 49; Putnam, 61; Wyatt, 91). Although this situation is understandable (foreign language educators cannot wait until every research question is answered about how CALL can best be designed before beginning to use the medium), the profession needs to give serious consideration to the likely effects of such a lopsided approach.

There are many ways to ensure the best possible use of CALL. Surely careful programming, thoughtful instructional design, good sense, intuition, and sensitivity to students' needs all are necessary; but they are not sufficient. The profession must undertake research that provides an empirical base for assumptions, strategies, and applications of the computer in language teaching, lest another powerful tool for language learning not realize its potential. Starting form a historical perspective of research on the language laboratory, the purpose of this chapter is (1) to analyze and evaluate comparative and applied research on CALL, (2) to provide a theoretical base that illustrates the need for more basic research on CALL that considers computer capabilities, learner differences, and the learning task in concert, and (3) to evaluate basic research in CALL.

Media in Perspective: The Language Laboratory

The language laboratory of the late 1950s and the 1960s is viewed by many in retrospect as an unfortunate venture that resulted in a loss of credibility for language education and a growing suspicion among teachers about the value of mediated language teaching in general. The major flaw of the language lab movement was the introduction of the medium with virtually no systematic research except on its engineering aspects (Stern, 84).

A perusal of the literature from 1959 to 1962 reveals that the language lab was viewed as a miracle worker too often foisted upon the unwary (Smith, 79). Most language teachers, however, welcomed the pseudo-credibility that the new technology afforded the profession and touted its potential as a "taskmaster" (Siciliano, 76, p. 224), a "private tutor" (Young, 92, p. 221), a milieu for a "fully automated language workout"

(Mathieu, 44, p. 352), a means by which the teacher could "enter into a much closer individual relationship with each of his students" (McGraw, 47, p. 218), a resource that would "multiply the good teacher" (Hocking, 25), "the most important technological aid to language teaching" (Huebner, 33, p. 109), and "the most important advance in language teaching efficiency" (Stack, 82, p. x).

These plaudits were rebuffed by others, however, who were skeptical about the lab's value. For example, Koekkoek (39) and Mustard and Tudisco (54) indicated that in spite of optimistic projections, many teachers had basic questions concerning the language lab, which adherents failed to answer. In words that would ring equally true today, Dostert (18) warned teachers to be less enamored of sophisticated hardware and to work instead at creating flexible and appropriate materials.

From its earliest use to its widespread dismantling in the late 1960s and early 1970s, the failure of the language lab concept has been blamed on a lack of appropriate audio and visual materials (Davies, 16), oversell (Holmes and Kidd, 27; McCoy and Weible, 46), inflexibility (Underwood, 89), and negative reactions from students (Rivers, 63). All these explanations are partially accurate in describing the decline of the lab, but they fail to identify the major source of the problem: No research was conducted on how best to utilize the technology to enhance language learning. The limited comparative studies (e.g., Keating, 38; Lorge, 42; Smith, 80) added little to knowledge about the technology and provided almost no direction on how best to manipulate specific potentials of the medium. Without adequate research to enable appropriate software to be designed, the language laboratory was doomed to fail.

CALL: Have We Learned Our Lesson?

One parallel between the profession's anticipation of miraculous results from the language laboratories of the 1960s and the impact expected of CALL in the 1980s is particularly noteworthy: There is still little research on effective pedagogical manipulations of the medium to guide the instructional designer, author, or practitioner.

For example, in discussing principles to follow when designing CALL, Curtin and Shinall (14) assert that students "should be challenged but in control of the material" (p. 12), without providing evidence why. But recent research in first-language computer-assisted reading indicates that program rather than user control of the display rate of a text typically results in higher reading speed and increased reading comprehension (Belland et al., 6). And at least one CALL study has indicated that program control over the display of a reading passage during comprehension checks via questioning results in more retention (Pederson, 58; 59).

Other testimonials similarly fail to cite research results largely owing to

the inadequate investigatory procedures used to tout the computer's potential for effective CALL. What are cited are informal observations and attitude questionnaires (Taylor, 86), personal experience and student responses (Scanlan, 70), and surmised superior efficiency (Post, 60). In an article describing the positive reactions of students using CALL in first-year French, Hope (28) counsels that the need for research into CALL is exaggerated since "all devices are effective to the extent to which they are used efficiently and enthusiastically" (p. 350).

Second-language education is not alone in its failure to investigate theoretical issues and societal assumptions in the application of technology to education. Diamond (17) has observed that instructional design throughout much of its history has based most of its success on hunches and personal experience across disciplines. In the same vein, Eisele (20) observes that "scarcely anyone is now opposing the use of computers for learning; but, neither is anyone able to pronounce the *real* value of their use with any degree of confidence based on research" (p. 34).

Is it inevitable that "the bandwagon-to-pratfall history" of the language lab will be repeated (Arthurs, 4, p. 38)? Will CALL software ever begin to reach the level of pedagogical sophistication that many have claimed for it? What can be done to provide the complex information that instructional designers need to make informed decisions about how best to manipulate the many coding elements inherent in CALL? In short, what kind of empirical findings can best add to the highly limited theoretical base that exists in CALL and direct its applications?

Research in CALL: Analysis and Prognosis

Whether foreign language educators decide to commit themselves to dispassionate, controlled research on CALL and its potential will determine to a large extent its ultimate credibility, longevity, and efficacy. The financial and human resources available for conducting this research are, unfortunately, quite limited. Holmes (26) warns, with respect to the use of computers to teach languages, that the profession must ask, "Do the benefits justify the time, energy, and money?" (p. 414); so too, must the profession consider carefully which CALL research efforts to fund. Studies should be undertaken that have the greatest probability of (1) providing language teachers and instructional designers with the greatest amount of and the most useful information possible, and (2) achieving longevity (i.e., not being obsolete before they are even printed) in spite of the rate which technology is expanding.

The following sections consider several different types of research and the likely resource (cost-time-energy) benefits that each stands to provide. An analysis of the purposes and limitations of several types of research (comparative, evaluative, basic) along with representative CALL studies

that have been conducted to date should provide direction for future CALL research efforts.

Comparative Research Studies

Sample CALL Projects. Comparative research (medium A versus medium B) predominated prior to the mid-1970s. Morrison and Adams (52) conducted an exploratory investigation on the difference in achievement between first-year college students of German who studied using CALL and students who were taught using ALM language lab materials. Results after one year showed no difference between the CALL group and the lab group in overall achievement nor, similarly, in the four skills.

Other studies that compared CALL with traditional classroom learning (Adams and Rosenbaum, 2; Barrutia, 5) found no significant differences in learning that could be attributed to the CALL treatment. Williams (90) conducted an investigation to determine whether students enrolled in second-semester college French could learn five grammar points effectively through computer-assisted instruction as could others enrolled in conventionally taught language classes. The overall findings were that CALL students learned as well as but not significantly better than traditionally taught learners. Mellgren (48) attempted to determine the effect of computers on achievement in junior high school students of Spanish, but found no difference between the treatment group that completed written tasks with paper and pencil and the one that performed all assignments on the computer. These studies, however interesting, provide little usable information outside of their specific setting; for all, in one way or another, fall into the trap of attempting to attribute learning gains to the medium itself rather than to the way the medium was manipulated to affect achievement.

In recent years, researchers have shown marked improvement in the design of CALL studies though, unfortunately, many still overgeneralize the results and apply experimental outcomes to contexts not investigated. For example, Schrupp et al. (75) undertook to justify the cost of interactive video (IAV) equipment (video instruction driven by a CALL program) for language teaching at the U.S. Air Force Academy by demonstrating evidence of learning gains from use of the medium through study of a construct defined as "interactivity." On first consideration, the investigation appears appropriate and the results applicable to other institutions, until one stops to consider the fact that "interactivity" encompasses a wide range of IAV variables, including multiple trials, feedback (in the form of hints and provision of correct answers), remedial video replay, and unlimited time on task. Schrupp et al. write that the study endeavored "to measure any quantifiable advantage in learning outcome attributable to computer-assisted instruction [IAV treatment]"

(p. 17). Since the same comprehension questions that had been used as a strategy for practice in diverse treatments were reused as the dependent variable, the experiment was skewed seriously at the outset in favor of the IAV treatment whose students, not surprisingly, performed best. Clearly, any outcome of this experiment cannot be attributed with confidence to any one of these or any other unknown variable; in short, the results are of limited generalizable value beyond the specific experimental milieu.

Teichert (87) described an experiment to test the usefulness of the computer in aiding first-year college students of German to learn vocabulary and grammar, limiting one of the independent variables to "the materials." The CALL materials, however, were not described and delimited adequately for the reader; therefore, to ascribe to "the computer" itself the ability to bring about learning gains is entirely misleading, for the results were actually a function of the unknown characteristics of the CALL software used. As a result, any statistically significant differences cannot be ascribed to a replicable variable. Teichert identified 21 grammatical structures from the syllabus studied in class; the control group studied them via conventional workbook exercises and the experimental treatment completed CALL modules. As compared to the control treatment, the CALL modules held these features: immediate feedback, suggestions for review, repetition to 80 percent mastery, and "help." The results indicated that the CALL treatment group scored 10 percent better on the departmental posttest; however, in addition to an incomplete description of lesson content, the problems involved in interpreting these results are many. First, Teichert reported that it is "possible" that the CALL group practiced the material more than the control class, an uncontrolled difference that illustrates one of the built-in limitations of comparative research. Perhaps more important, even if the legitimacy of the 10 percent differential between groups were unquestioned, results attributed to CALL treatment overall can be neither interpreted nor ascribed ecological validity—the likelihood of being replicated elsewhere (Bracht and Glass, 8). In short, there is no way of knowing exactly what variable(s) in the CALL materials in question caused the reported results.

Dursky (19) compared the effectiveness of a CALL instructional format versus programmed learning for teaching Latin and Greek derivatives to first-year college students. Dursky hypothesized that because one medium is interactive (computer) and the other is somewhat passive by nature (programmed instruction), learning via the two would interact with personality types and learning styles. The research design, which moves a step beyond those that attempt to show that computers can teach any student as well as or better than some other medium, still holds a major flaw: the independent variables are not conceptualized theoretically and then described adequately. Dursky found that no differences emerged from the two treatments as measured by end-of-term tests and

that none of the learning styles or personality-type variables interacted with the mode of instruction to affect achievement.

Even as recently as 1985 a major comparative project was conducted by Lozano et al. (43) at the University of Colorado to determine whether adding a weekly 45-minute CALL lab in place of one 45-minute language lab period for first-year college students would result in more effective teaching in listening, speaking, reading, writing, or grammar for beginning Spanish. After careful piloting, pretesting, validation, and revision of the criterion instruments, the experiment was conducted for an entire semester. The results indicate that the CALL group performed better than the lab group in the writing skill alone. Unlike much CALL comparative research that preceeded this experiment, considerable care was taken to ensure that (1) the intact classes were comparable, (2) other aspects of the teaching that occurred in both treatments were the same for both groups (including assignment of teachers to treatment groups, time of day classes were taught, and learning tasks) and (3) specific skills, as opposed to simple overall achievement, were tested.

The results indicated that some combination of the ways this particular CALL instruction was coded combined with the fact that the CALL group received 45 minutes less lab practice than the lab group resulted in better writing skills. But, because the independent variable (herein, mode of practice) is not delimited clearly for the reader, similar results could not be expected in the same practice format but with different software even in the same setting. In fact, the authors caution that all CALL software is not created (coded) equal. That the researchers were forced to write software to fit the students' needs illustrates the "situation-specific" nature of the experiment and, hence, the ungeneralizability of the outcome.

Theoretical Limitations. Comparative research on computer-assisted versus noncomputer-assisted language instruction is incapable of providing generalizable results for many reasons. First, there is no way to replicate the conditions of the experiment exactly; therefore, the results lack consistency (reliability) from place to place. If the independent variable, for example, is "use of the computer versus use of a traditional method," how can the classroom teacher in another setting be assured that his or her use of the computer will be identical to that of the primary study? Second, there is no valid way to ascribe with confidence the causes for differences in the dependent variables to the independent variables. Without adequate controls, all of the possible causes for learning differences between one medium and another cannot be explained adequately, and the researcher is left with the dilemma of concluding that apples (CALL), for example, are superior to oranges (the language lab). Third, such studies usually fail to hold hypotheses based on language-learning theory, and, as a result, it is impossible (1) to integrate their results into the constantly expanding language-learning theoretical research base, and (2)

to utilize the outcomes for adjustments in classroom teaching that will result in improved second-language learning.

Consider a typical, though fictitious, comparative study designed to show that CALL drill and practice is superior to paper-and-pencil workbook drill and practice. Suppose that the findings indicate that the CALL group of students perform better on the posttest than does the traditional workbook drill-and-practice group. Can it be asserted that CALL drill and practice, in general, is more effective than traditional drill and practice? What if the expected proficiency level of the students is changed; will the same results emerge? And what if students at a different age level are studied or the language of study is different? How can the researcher know which of the following variables might have affected learner outcomes:

novelty	learner expectations
feedback	place of practice
content	display mode and form
practice	cognitive response
answer-processing	motivation
response mode	audio
lesson format	. . .etc.

The point, however obvious, needs to be restated: *CALL, in and of itself, does not result in more and better learning; rather, it is the specific way instruction is coded in CALL software that has the potential of affecting learning positively, for specific learners in specific contexts.* All one can learn from the large comparative research efforts in mediated instruction is simply that if learning differences emerge in favor of one set of learners who used an unreplicable set of learning materials in an undefined context on a one-time basis, more learning occurred for one group than another, but one cannot ascribe the differences with confidence to any one variable.

In summary, researchers in instructional technologies have been discouraged countless times in the last decade from engaging in comparative investigations that attempt to show that one medium delivers instruction better than another. Hurly and Hlynka (34) have chided educators for placing emphasis upon a machine independent of its users; Ragsdale (62) reminds us that "one of the consequences of searching for ways to use computers has been a tendency to build from computer strengths rather than to build toward student weaknesses" (p. 3); Clark (12) notes that metanalysis after metanalysis of comparative studies from "five decades of research suggest that there are no learning benefits to be gained from employing different media in instruction, regardless of their obviously attractive features or advertised superiority" (p. 450); in fact, Clark warns that "studies comparing the relative achievement advantages of one medium over another will inevitably confound medium with method of

instruction" (p. 451); Schramm (74) reminds us that "a common report among experimenters is that they find more variance *within* than *between* media—meaning that learning seems to be affected more by what is delivered than by the delivery system" (p. 273); and finally Salomon (68) explains "the cumulative finding is that media per se have no consistent differential effects on learning" (p. 144). Unquestionably, the temptation is great to conduct a research effort that will demonstrate, once and for all, that CALL compared to other modes of language learning (however defined) results in more learning. Given all the pitfalls of such broad comparative research, however, the profession simply cannot again indulge in such naive solutions to complex problems. The question must be, "How do computers make a difference?" Appropriate CALL research is needed to provide *theoretical, explanatory,* and *practical* information about the specific ways the computer can deliver instruction that is particularly well-suited to specific language learners who, in turn, perform clearly defined learning tasks.

Evaluative Research

Purpose and Potential. Evaluative research is the most common form taken by applied research in CALL. Applied research is usually defined in relation to basic research. Basic research attempts to develop a theory of language learning and to provide explanatory principles for learning differences that emerge from ethnographic observations or controlled experiments; the purpose of applied research is to achieve practical objectives (solve problems, for example) in a specific learning situation or with a specific set of learning materials. To that end, the appropriateness of engaging in evaluative research is unquestionable.

One obvious practical problem in CALL is to provide evidence that a given software package is designed and programmed effectively. McCoy and Weible (46) note that reviewers must evaluate software packages intelligently, "reacting neither out of fear nor witless enthusiasm, but judging them truly on their merits" (p. 140). Haas (24) argues that sufficient guidelines for the testing and evaluation of CALL must be developed. Although intuition may play an important role in making the final match between software and student, evaluative research provides useful information on learning gains that may be achieved by specific users of a CALL package before the software reaches countless language learners. First, more precise documentation from software publishers is needed. In general too much leniency in this regard has been accorded software publishers. Courseware documentation rarely identifies the target learners, in fact the documentation from some CALL software claims that a given lesson can be "adapted" to fit a learner of nearly any age, at nearly any proficiency level, in nearly any context (Kyle, Pons and

Barnett, 40). Clearly, language teachers would never tolerate such vague marketing in the case of textbooks. Furthermore, the software reviews provided in nearly all professional journals (as useful as they are) can be no substitute for rigorous formative and summative evaluations during the process of creating the materials and readying them for market.

Steffin (83) offers useful guidelines for establishing the validity of software packages. They call for quantifiable data that (1) relate to specific educational objectives, (2) differentiate between the likely variances in potential users, (3) take the likely variations in instructional settings into account, (4) document opinions of a variety of users (not just software publishers or computer enthusiasts) concerning the software's quality. In short, language teachers should beware of evaluative research that claims more generalizability of uses and users than it can logically garner. The wise language teacher should examine evaluative research reports carefully for clear educational objectives, a specific target audience, and an adequate evaluative consensus from classroom teachers, students, and CALL experts. Only in this way can a good estimate be made of the quality of the match between the software and the potential student-user.

Finally, because evaluative research is software-specific, its results should not be published as research articles in professional journals. This recommendation does not diminish the importance of formative and summative evaluative research; it simply acknowledges the fact that most software evaluations become rapidly obsolete. Publishers make adjustments in CALL software on a continual basis. Thus CALL research that should be reported are those basic projects that offer new theoretical information about the psycholinguistic nature of language learning and the way in which a specific computer capability of delivering instruction—its coding elements—has been shown to affect or interact with the learning process. Such studies will stand the test of time.

Example Evaluative Projects. An additional form that evaluative research may take is the informal survey conducted, for example, by a language department that may wish to determine the degree to which students are satisfied with the CALL software being utilized. Several such surveys have been reported in the literature (Hope, 28; Scanlan, 70; Simonsen, 77; Taylor, 86), but unfortunately too often they are used as a vehicle to substantiate claims of medium superiority. Surveys are generally regarded as accurate indicators of student attitude and perception of learning gains (Moore, 51), but the results cannot be applied to a larger population than the one from which the sample is drawn (as is the case of comparative research). In addition, the learners' experiences are software-specific, and the research results should not be generalized beyond the software in question.

Other CALL evaluative research is designed to provide formative and summative data during and after the development of new materials. These studies attempt to evaluate a variety of factors. For example, May

(45) engaged in a rigorous series of pilot investigations that generated data to develop and refine a computer-based program to teach basic writing skills to ESL students. Terry (88) developed a useful model for determining cost per user-hour in his evaluation of MONIQUE, a French drill-and-practice driver program. O'Brien (55) ran a prototype feasibility/pilot study to examine if it would be possible logistically to implement CALL for drill and practice in his German department. Brebner, Johnson, and Mydlarski (9) utilized a comparative research design to evaluate nine drill-and-practice lessons in French. No differences in learning resulted between traditionally taught students and the experimental group.

Finally, a rather encouraging development in the area of evaluative research on CALL has emerged recently. Language programs are beginning to turn to a consultant or a group of consultants to provide an analysis of CALL software needs, and of how best to meet them. Fought et al. (21) have recently completed an extensive project on behalf of the Defense Intelligence Agency. After in-depth interviews with potential users, a review of CALL software and of possible short-term and long-range solutions, several workable suggestions for the implementation of CALL have been provided to the DIA, all of which respect Steffin's (83) counsel that learner differences, the context, and the purpose for language study, as well as previous evaluations of the software, need be considered in evaluative research.

Basic CALL Research

Purpose and Potentials. Recently, CAI theorists have become aware of the need for a greater percentage of future research to move beyond evaluative models toward more theoretical (basic) designs. Spitzer and Kielt (81) have observed that "through the standard procedures of evaluative research we are rarely able to understand the complex nature of the effects of the educational technology with which we are dealing" (p. 20). Another major benefit of engaging in basic CALL research in second-language education is that the researcher is constrained to adopt a dispassionate attitude toward the medium. Unlike comparative research (which has as its purpose providing evidence that CALL is effective) and unlike evaluative research (which attempts to document the quality of a given software package), the purpose of basic research is to discover something about the way students best learn a second language. Meredith (49) calls for more studies such as those conducted by Omaggio (57) and Mueller (53), which were designed to determine how variations in the use of a specific medium affect language learning. If a difference can be shown in favor of the way a specific coding capability of the computer can deliver instruction in a given circumstance for a given set of learners for a given

learning task, then basic researchers should attempt to integrate what is already known about language learning into their discussion of how this new knowledge supports, refutes, or elaborates the theoretical base that already exists (Jarvis, 36). Likewise, such research results should provide CALL instructional designers with needed information that cannot be gathered solely through hunches, extrapolation, and intuition.

A Theoretical Base: Gavriel Salomon. Gagné (22) asserts that it is time for a new approach to the study of media and points to Salomon (66, 68) for a theory that abandons the atheoretical bent of the past and provides a much-needed, convincing, and workable model for designing media research. Salomon's model takes into account the three most important variables in mediated instruction: the learner, the learning task, and the coding elements.

There are five basic tenets of Salomon's theory that are of particular importance to the design of CALL basic research:

1. *The ways a medium stores and delivers instruction (its coding elements) rather than the medium itself stands the best chance of affecting cognition.*
   The way CALL materials are designed and not the simple use of CALL versus some other medium is what will probably affect learning outcomes.
2. *These coding elements often mirror or activate a cognitive subskill in human learners (focusing, organizing, highlighting). These subskills are often those most affected in students as a result of the use of the coding element.*
   Word order accuracy, for example, will probably be affected by use of the computer's ability to remove cues from the screen during written answering, because this coding element activates that subskill in the learner.
3. *Different learners are affected in different ways by the use of any given coding element.*
   The removal of cues for early beginners performing written pattern practice, for example, may prove to activate and enrich the skill in high-verbal-ability learners, while it may serve to frustrate low-verbal-ability learners.
4. *Different learners are affected in different ways by their perceptions of the task expectations related to their use of instruction that is transmitted via a given coding element.*
   If a learner perceives, for example, that the instructor is not particularly concerned about accuracy in the placement of diacriticals, then the use of the computer's display coding element of highlighting errors and requiring correct insertion of accent marks before moving on will probably result in less retention of correct use of diacriticals than if the learner is aware that learning how to place accent marks is very important to success in his or her language class.

5. *A medium's coding elements often will interact with related learner differences and related learning tasks.*
   For example, students whose learning style lends itself to accuracy will respond differently to the above example than ones who tend to fail to pay as much attention to detail. As a result, it is likely that degree of retention of diacritical placement will probably reflect the following declining order:
   a). Accurate learners who believe the instructor requires accuracy
   b). Inaccurate learners who believe the instructor requires accuracy
   and
   Accurate learners who believe the instructor does not require accuracy
   c). Inaccurate learners who believe the instructor does not require accuracy

Salomon relies heavily upon Cronbach's Aptitude-Treatment Interaction (ATI) model (Cronbach and Snow, 13), which predicts that most students' individual differences will interact with the way they are taught and result in differential learning outcomes (see number 5 in the box above). Thus Salomon adds to aptitude and treatment a third variable, coding elements of a medium. In media research, the coding element rather than the medium itself stands to make the greater difference in instruction. Salomon encourages researchers to conduct studies that investigate relations among aptitude, learning tasks, and coding elements, because this type of investigation allows the most essential attributes of a medium and their related psychological functions to be studied together toward identifying how specific learners can be taught most efficiently and effectively. The three important elements of Salomon's design are detailed below.

Symbol systems and their coding elements. Salomon (68) defines media as "our cultural apparatus for selecting, gathering, storing, and conveying knowledge in representational form" (p. 3). Any medium, such as CAI, is made up of many symbol systems, among other components. For example, in CAI, one important symbol system is *display*. The subcategories of a symbol system are its coding elements, those potentials of the symbol system to deliver instruction in particular ways. The symbol system display consists of many coding elements, including color, graphics, rate, timing, format, clarity, and print size. Symbol systems are of crucial importance to the instructional designer and researcher because they isolate particular ways in which a medium "relates cognition to learning" (p. 1). Rather than assuming, for example, that a medium as complex as CAI can be shown to make a difference, Salomon emphasizes the need to isolate an essential attribute of a medium that may affect learning and to examine it in relation to what is known about language learning.

Furthermore, Salomon asserts that, in spite of misconceptions, the subcategories of a medium's symbol systems—its coding elements—are not invariant (65). For example, a coding element such as "random

access" can be utilized in such disparate media applications as a videodisc slide presentation (in which, for example, a computer can randomly access visuals to assist a student of French in reviewing various architectural aspects of major monuments in Paris) and flash cards (in which, for example, a beginning student of Russian can shuffle the cards to practice identifying letters in the Cyrillic alphabet).

In short, Salomon insists that no coding element can be attributed solely to one medium. Each medium, however, does "translate" coding elements in ways that will result in some differences from other media's utilization of them (e.g., the videodisc is capable of performing random access tasks much more efficiently than a person shuffling a deck of flash cards).

Task requirements. Research on use versus nonuse of coding elements alone cannot be expected to yield satisfactory results. The learner's task orientation (perception of what is supposed to be learned) will determine the effect of a given coding element. Salomon describes this interaction in terms of selective attention. In short, students tend to assume that certain ways in which CALL is presented deserve special attention, depending upon their perception of the task they are expected to perform. In essence, students extract the information from CALL materials in a way that leads to optimal success in completing the learning task while at the same time internalizing (as noted by Weible in Chapter 3 of this volume) strategies of understanding and application that are reflected in future, related learning tasks. The wise instructional designer uses coding elements that learners perceive will help them to perform well.

It stands to reason, then, that a learner who believes the task of reading French is a matter of comprehending strings of words will respond differently to the use of the coding element "delayed display" (i.e., the timed, sequenced display of a reading text that adds one word at a time) than the learner who views reading French as a higher-level processing task in which frequent forward and backward eye regressions are needed. Hosenfeld (30, 31) illustrated how language learners are extremely conscious of task orientation. She found that language students tend to be very efficient problem-solvers and know how to take shortcuts. For Salomon, the essential research question in choosing the combination of coding element and task variables to investigate is whether the mental activities that the coding element activates are task-relevant. For example, because the use of the coding element "color display" (as opposed to monochromatic display) probably would have little bearing upon the retention of a reading text, it is unlikely that a study investigating the effects of color enhancements upon retention in reading will yield much useful information to CALL instructional designers. Much more useful would be investigations concerning display rate, display size, length of reading passages, frequency of interspersed comprehension questions, and other, more task-relevant coding elements.

Finally, Salomon has shown in research on film (67, 68) and television for children (68) that "increased experience with coded messages improves one's skill in extracting information from such messages" (68, p. 113). Put simply, the interaction of the coding element with the task can "short-circuit" a skill (perform extra processing that noncoding would normally require of the learner instead, such as "shuffling" the deck of Cyrillic alphabet cards); it can also code elements so that they can "activate" and "supplant" existent cognitive skills. Salomon has found that children who lack cognitive skills (such as focusing on the major point) can be taught to activate them by practicing these skills through their interaction with video presentations that use related coding elements effectively. Investigations should be conducted on the ways in which well-designed CALL software that uses coding elements efficiently may be able to activate and cultivate dormant but needed metacognitive strategies (developing strategic competence, acquiring vocabulary through listening comprehension, imitating phrases that are "turned" in a novel manner in the target language, raising the level of processing from a syntactic to a semantic level) in nonnative speakers. Such research has the potential of providing information to instructional designers toward delivering instruction that teaches languages while teaching students how to learn them.

Learner variables. Salomon relies heavily on Cronbach and Snow's (13) analysis of the importance of individual learner differences but rejects the notion that any medium's coding element can serve all learners equally well. Goodman (23) concurs that in CAI research student variables are among the least likely factors to be given consideration by researchers in spite of their crucial nature.

Learner differences are complex and perplexing. The researcher needs to take into account such disparate contributing factors as cognitive development, preference for learning style, aptitude, and experience (available schemata). Because learners vary in their ability and willingness to adapt to task and coding demands, one can expect that (1) a specific use of any coding element will not be best for all language learners, and (2) that some interactions among aptitude, task, and coding element will emerge in CALL experiments. Therefore, in research design, Salomon urges the choice of the coding element that seems to be in best "correspondence to—or in contiguity with—the mode of internal representation that an individual with a given cognitive make-up and task can best utilize" (68, p. 73). Lesgold and Reif (41) cite convincing evidence for basing coding choices on known human information processing rather than on computer potentials, a necessary approach because discerning the match between the cognitive demands of a learning task and the processing demands of a coded message offers the best choice of providing experimental results that can be used as a model to enhance learning.

Research that fails to take learner differences into account falls into a

trap similar to that of comparative research that seeks to demonstrate that one medium communicates better than another. Tasks that are coded by one medium cannot be expected to require the same amount of translation (cognitive drive needed to integrate the new material into an individual's cognitive structure) or elaboration (higher-level processing needed to make sense of new information) by all learners. Goodman (23) and Montague (50) note the key role that mental representations such as cognitive mapping play in cognition and call the inadequate consideration of these constructs in research the most untapped theoretical base; similarly they counsel that this area may be the most potentially fruitful for advancement in CAI research design.

In short, because language is processed internally by individuals with many different aptitudes, learning styles, and learning preferences, the key learner variable(s) that are called into play must be considered in research design along with task(s) and coding element(s). Without consideration for individual differences, the design of media research assumes that specific language-learning tasks are always best coded in specific ways. Although this type of research moves a needed step beyond that which compares, for example, learning in a traditional context versus learning via CALL, it still falls short of accounting accurately for the likely causes of variance in learning outcomes.

Salomon's model for media research in education can be applied easily to CALL. Such studies should be based on a foundation that takes into account the psycholinguistic factors that are known to play a crucial role in language acquisition. Furthermore, research on educational media should be holistic in the sense that it examine three crucial variables: coding element, task, and learner differences (Salomon and Clark, 69).

Types and Examples of Basic CALL Research

Experimental Research

The most obvious type of basic CALL research is experimental in nature. Such studies attempt to investigate the effect of the existence or manipulation of independent variables (learning styles, aptitude, learning task, the coding elements of the computer) upon dependent variables (achievement or attitude). Experimental studies are controlled and disciplined. Variables are chosen on the basis of language-learning theory, and the researcher develops one or more hypotheses that the independent variables under study may result in differences in the dependent variable (usually achievement) or interact with them.

One of the earliest basic CALL experiments was conducted by Schaeffer (71, 72) who studied how students are able to understand the content of

materials presented in a drill or exercise format, that is, their levels of processing. The results of Schaeffer's research reaffirmed that value of higher-level processing (meaningful language practice) and extended our understanding of the value of contextualizing even language drills, while providing a needed first indication that meaningful practice is possible on the computer. Schaeffer hypothesized that the beginning language learner will usually exert the smallest amount of effort possible to accomplish a learning task. He therefore predicted that, in their interaction with CALL materials, learners would attend to semantic features of the language in drill-and-practice sentences only if such additional processing beyond the syntactic level were necessary for completing the learning task.

In a highly controlled experiment, undergraduate first-semester students of German were placed in one of two treatments after having received instruction on the present perfect tense. The first group practiced sentence-length exercises that focused on structure and required attention to the predicate only. The second group practiced semantic exercises that required focus first on the meaning of the sentence and secondarily on form. After one hour of study, the semantic group scored significantly higher on the semantic items in a criterion-referenced posttest composed of both syntactic and semantic problems. Although the difference between the two treatments in the syntactic items' postscores was not significant, the semantic group scored somewhat higher on that measure as well. Schaeffer attributed the differences between the two measures to the task variable (syntactic or semantic practice) and concluded that "while knowledge of the grammatical structure was the only requirement [for success] on the structural subtest, the key to successful accomplishment of the semantic task [demonstrated] a deeper level of [cognitive] processing" (71, p. 70). Schaeffer's seminal study demonstrated that even in the much-maligned drill-and-practice format, students can be oriented to process language meaningfully as a result of the careful preparation of learning materials.

Johansen and Tennyson (37) investigated the degree to which learner control of instruction (and learning gains) can be facilitated by using the computer to instruct the student on how to make instructional choices. Students were expected to learn punctuation rules for English via one of three treatments: advisement and full and partial learner control. The advisement learner-control group received guidance on how to proceed through the program (what branching choices to make) based on success in mastering the material, but after a short preliminary lesson was permitted to make its own decisions. The full learner-control group was able to choose its own practice units and could review at will with no guidance from the program based on learner success. The partial learner-control group was provided with a program-controlled preliminary CAI practice lesson on punctuation-rule learning and then was told to make its own choices (about what to practice or review) without advisement thereafter.

A comparison of results indicated that the advisement learner-control group performed best on a criterion-referenced posttest, providing evidence that instructional designers may code CALL software in such a way as to use the computer to teach strategies of instructional management. This study thus provides support for Salomon's assertion (66) that optimally coded CAI can activate dormant or underdeveloped metacognitive strategies. Perhaps even more important, it offers instructional designers needed preliminary information concerning how best to code CALL learning materials. Additional research is needed, however, to determine if advisement learner control interacts with related learner variables (field independence, locus of control, and aptitude).

In a related study in second-language education, Pederson (58, 59) examined three hypothesized independent variables related to levels of cognitive processing during CALL reading practice in French: verbal ability, type of comprehension question, and passage availability. The investigation was based on previous second-langunge research that indicated clearly that task orientation and level of processing (meaningful reading) are crucial variables in language practice. The coding element, passage availability, was defined as the computer's capability to keep a reading passage displayed on screen or remove it from the monitor during comprehension questioning. It was hypothesized that removing the passage would induce a higher level of processing in second-language readers, and thus, like the Schaeffer experiment, result in higher retention of the material presented in a reading text. The 2 x 2 x 2 factorial design (indicating three independent variables, each with two different treatments) was based on passage availability versus passage unavailability; low-level comprehension questions versus high-level comprehension questions; and low verbal ability versus high verbal ability. Students participated in the experiment for a single 50-minute period. All students read the same selection but, depending on their random assignment to treatments, answered either high-level (integrative) or low-level (vocabulary) questions, with or without the passage available for reinspection during questioning. After practice, learners wrote down as much as they could remember about the selection they had read. These data (protocols), in turn, were scored using a weighted propositional count (a listing of all idea units in the text, which were assigned values according to their relative importance to its overall meaning) to determine the dependent variable, recall. In addition, several simultaneous, unobtrusive measures (trials, correct responses, response latencies, and time on task) were collected by the computer for the purposes of hypothesis generation.

Experimental results indicated that passage unavailability during the answering of comprehension questions led to more retention. Furthermore, low-verbal-ability subjects showed less capacity to derive learning benefits from passage unavailability than did high-verbal-ability subjects. Finally, as expected, those subjects who answered high-level questions

recalled much more from the reading than those who practiced low-level questions. This study reaffirmed that unneeded adjunct comprehension aids (e.g., low-level questions) may have distracted high-verbal-ability readers from attending to the meaning of a text, causing them to recall less than had they not been questioned.

The results from Pederson's investigation, while extending the research base that indicates that meaningful (contextualized) practice is better than mechanical (isolated) practice, illustrates that the particular use of a specific computer coding option (such as passage availability) can result in learning gains that are statistically significant for both high- and low-verbal-ability learners. Furthermore, these results lead to many other questions that are deserving of investigation: Can second-language learners be taught to reconstruct a reading text mentally and systematically while avoiding consultation of the text during comprehension questioning in order to enhance retention? Will long-term interaction with maximally coded CALL reading materials lead to purposeful reading strategies that help the learner even when the student is reading from the printed page? Are there any learner variables (such as locus of control or field independence) that will interact in CALL with the facilitative effects that have been shown for passage unavailability?

Two studies have provided useful information on the interaction of some of these learner differences and CALL. In the first, Chapelle and Jamieson (11) conducted a carefully controlled experiment to discern if ESL learners' choice to engage in CALL practice would serve as a predictor of success in language acquisition. Students in an intensive English program were invited by letter to participate in the research project that incorporated ESL CALL lessons in grammar, listening, and reading delivered on PLATO software. Unlike much previous comparative research, Chapelle and Jamieson provide a detailed description of the CALL programs used and the acknowledgment that "CALL effectiveness cannot be looked at as though CALL represented one form of instruction and all students were in need of that kind of instruction" (p. 42).

The variables examined were field independence/dependence (where field independence was defined as the ability to discern multiple meanings for ambiguous speech acts), ambiguity tolerance, motivational intensity, English-class anxiety, attitude toward CALL, voluntary time spent using CALL, and proficiency in English. The first research question—whether cognitive/affective variables would be related to attitudes and time spent using CALL—revealed a significant negative correlation between field independence and time spent using CALL. Likewise, a negative correlation emerged between field independence and attitude toward CALL. A positive correlation was found between CALL use and students who had high motivational intensity. Neither English-class anxiety nor ambiguity tolerance revealed a significant correlation with CALL. The data were analyzed to determine if both high

motivational intensity and field independence were necessary to account for the variance in CALL use. The results of multiple regression analyses indicated that field independence was the exclusive predictor for time spent using CALL. Field-independent students did not like and failed to use the CALL lessons voluntarily in comparison with their field-dependent counterparts. Chapelle and Jamieson attribute these results to the coding of PLATO's ESL lessons, rather than to CALL in general, stating, "it is likely that the field independent students, who are capable of and accustomed to using their own internal referents, found the structured approach of the lessons in the ESL PLATO series to be inconsistent with their learning styles. They may have found it irritating to have information and exercises structured in a way different from how they would have done it themselves" (p. 38).

The second research question Chapelle and Jamieson examined was whether CALL would serve as a predictor of achievement in English beyond what can be estimated by entry-level achievement or affective/cognitive characteristics (field independence, ambiguity tolerance, motivational intensity, English-class anxiety). The researchers found that time spent in CALL was not a significant predictor of end-of-semester English proficiency.

This study provides useful preliminary indications of the necessity of giving adequate consideration to learning styles and attitudes in the design and use of CALL, and the need to include learner variables in the design of CALL experiments. Clearly, learner characteristics are capable of accounting for both learning differences and of interacting with other variables. Without attention to such constructs, research into CALL risks arriving at results that cannot be generalized with confidence to equal populations of students.

In a related study, Jamieson (35) used the computer as the medium of instruction for several purposes: (1) to investigate the effects of cognitive style (field independence and reflection/impulsivity—*studied* versus *quick* decision-making) upon achievement and (2) to identify work styles—deliberate approaches toward task completion—exhibited by learners interacting with CALL and their relationship with cognitive styles and achievement.

Advanced ESL students utilized CALL materials to practice spelling and dictation. The computer's accurate and untiring ability to count student errors and to record response latencies was the sole means used to determine work styles related to accuracy and speed. Various components of the TOEFL test were used as dependent measures. Results indicated that field independence was related to all measures of language achievement, while reflection was related to improvement on the TOEFL structure test. It was found that interaction rate (a combined measure of time and accuracy in responding) and monitoring of linguistic input (number of times students requested to hear cues from audiotapes) related

negatively to achievement. Monitoring linguistic output (as measured by the number of edit/erases of the learner) was not related to any of the achievement measures. Work styles and cognitive styles exhibited some relationships. For example, field independence and impulsivity both related to response time (subscore of interaction rate). Reflective subjects both were slow while working on the CALL lessons and also requested to listen to the audio cues more often than impulsive students.

These findings show that computer software design needs to take both cognitive style and likely work style into account in the provision of options, timing, and the way scored exercises are tallied in order to enhance student motivation and student control. However, much more research on specific issues will need to be conducted before implications for specific instructional design decisions can be drawn with confidence.

Studies that use the computer as a research tool for data collection provide information that has long been unavailable to language education researchers (Abraham, 1; British Council, 10; Dalgish, 15; Simonsen, 77). Simultaneous practice measures (response latencies, trials, time on task) that have the potential to provide evidence about learning strategies during CALL practice and to generate data for statistical analyses concerning strategy/learner style interactions should continue to be collected in future CALL research efforts.

Perhaps the most ambitious CALL experimental endeavor to date has been conducted by Robinson et al. (64) at the Center for Language and Crosscultural Skills (CLCCS) in San Francisco. The authors posited several hypotheses (each based firmly in second-language education and psycholinguistic research) concerning the ways in which the computer's coding variables may stand the best chance of interacting with second-language learning. The purpose of the research was not to prove the effectiveness of CALL in general, but to provide evidence of how the manipulation of certain CALL coding elements may be particularly well suited to encouraging meaningful, communicative, and maximally facilitative CALL. In short, the CLCCS research design illustrates a pedagogical rather than a technological rationale for generating research questions and selecting variables.

Six pedagogical and four answer-judging hypotheses were posited. The pedagogical hypotheses predicted improved achievement as a result of the following types of materials presentation:

1. Integrated context for discrete structural items
2. Meaningful practice of structural items
3. Reference to people that students knew
4. Use of humor or emotion in order to involve the learner personally
5. Student choice of general context
6. Higher-level cognitive tasks (drawing inferences or problem solving)

The four answer-judging hypotheses predicted greater learning gains for

students who, when they answered incorrectly, were

1. Given feedback that caused them to discover their error
2. Provided assistance with a degree of personal control whether or not to use it
3. Provided with implicit rather than explicit correction
4. Given the same items to practice again at spaced intervals

Students were given two tests prior to the study: the Pimsleur Language Aptitude Battery (PLAB) and a specially constructed test of prior knowledge of Spanish, based on the language material to be covered during CALL practice, also used as a posttest. For nine days, junior-high students practiced Spanish with CALL materials designed especially for this experiment. Each hypothesis was tested using identical materials except for the single variable under inspection. Each day, after approximately 20 minutes of CALL practice, the learners were given a short test to determine any progressive learning gains. Several posttests of achievement, attitude, and aptitude were administered after the entire series of subexperiments was conducted. The results showed that the experimental group (students who practiced with CALL vis à vis the ten hypotheses above) significantly outperformed the control group (students who practiced under the opposite conditions) in cumulative achievement and when scores were mediated by prior knowledge. That is, the results suggested that meaningful and discovery-oriented CALL leads to more learning than CALL that is less communicative and more directive. Although the study clearly identified and isolated variables in the experimental treatment, these larger findings may have limited value for future CALL development owing to the problem of ascribing gains in *cumulative* achievement to any one particular variable. It should be noted however, that the CLCCS study did emphasize variables that have a strong pedagogical base in the research that shows meaningful practice and discovery learning both result in higher achievement in language learning than does mechanical practice.

On the other hand, the results from the individual subexperiments on various types of answer judging defined in the CLCCS study provide the most specific and therefore immediately useful information for CALL instructional designers. In three cases, all of them answer-judging experiments, the experimental group outperformed the control group significantly—student discovery of errors, combination of student control over and program feedback for help, and implicit correction. These particular results provide compelling evidence for the future coding of answer processing in CALL materials in ways that will cause the learner to be engaged actively in discovering his or her errors.

The statistically significant results in favor of the control group are less instructive, for example, where the CALL lessons named persons known to the students and provided meaningful rather than simple manipulative

practice, the control groups outperformed the experimental groups. The researchers suggested many reasons that a discrepancy would emerge between daily subtest scores for the pedagogical hypotheses and cumulative achievement scores, the most plausible being that immediate recall (which was accessed in the day-to-day subtests) is an unreliable and even inappropriate measure of learning. The entire investigation probably would have benefited from delayed retesting to allow more accurate measures of differential learning to occur, but that was not feasible in this experimental setting.

The CLCCS study provides considerable impetus and a worthy model for continued investigation into specific ways in which the computer's coding of CALL can be shown to interact with effective language-learning strategies. In the future, it is hoped that more experiments of this type will be conducted and that they will take the learning task and its related coding element into account. Furthermore, future research should investigate related differences in learning style, learning preference, and aptitude as independent variables in addition to simply controlling for them.

Ethnographic Research

In addition to experimental studies, data are needed that will identify what type of hypotheses should be tested empirically. Ethnographic research on CALL provides insights to that end. The ethnographic researcher usually enters the natural domain of CALL (the classroom or the learning resource center) and through a variety of unobtrusive techniques, including carefully controlled observation and interviewing, gathers data that are then examined as a source of hypotheses concerning the nature of language learning or the effect of materials, strategies, or curricula in place. The ethnographic CALL researcher attempts, as much as possible, to relate learning patterns and variations to previous second-language education research. Furthermore, data are often subjected to quantitative analysis to ensure accuracy and to facilitate interpretation. Rather distinct uses of ethnographic methods have been used in three extensive CALL research projects (Lozano et al., 43; Blomeyer, 7; Robinson et al., 64).

Lozano et al. (43) attempted to discern if a CALL adjunct to a traditional first-year college Spanish curriculum would be more beneficial than using the same amount of time for scheduled language lab practice (see "Comparative Studies" above). In addition to the extensive quantitative data collected from pretests, attitude questionnaires, posttests, learning checks, and attendance records, the researchers decided to enhance their study's design and explanatory power by including ethnographic observations. A single ethnographer was given the task of observing the classes and lab sessions under study at the University of Colorado, interviewing students and instructors to discern attitudes and

problems with the procedures and materials, and reporting on tendencies, variations, and patterns. The researchers indicated that the ethnographer's observations during the pilot study were particularly useful in eliminating irregularities in the teaching that occurred in the individual class sections. Of particular interest to the CALL researcher are the observations made during student use of computers and other lab equipment. The data indicated that students using the computer lab had a more positive attitude toward required lab practice than those who used the language lab.

The CLCCS study reported above (64) also incorporated an ethnographic approach. Interviews with students were recorded on videotape in the computer lab and in classroom discussion sessions as were sessions with staff and observers. The transcripts of the interviews provided in the final report revealed information that would probably never have come to the attention of the researchers and teachers, though it was accessed solely through asking people what they were thinking and why. The ethnographic data revealed both positive and negative views toward CALL practice. Overall, five positive general comments emerged: (1) the computer was a forgiving tutor, (2) the computer treated all students the same, (3) self-pacing and individualization were viewed as beneficial, (4) students were more motivated to stay "on task" than in regular classroom activities, and (5) students became more computer-literate. The negative comments referred to the fact that (1) the computer was too inflexible, (2) its novelty wore off after a while, and (3) it was impersonal.

A study by Blomeyer (7) is a third example of ethnographic research. Blomeyer examined the use of CALL as a curricular innovation in two on-site case studies in high schools and through a study of policy analysis in order to make "a preliminary assessment of its [CALL's] impact on the practices common to second language teaching in secondary schools" (p. 5). Data were collected within the classrooms and in microcomputer laboratories, through interviews with teachers, students, and administrators. Some of the most interesting preliminary findings were that no specific characteristics of the CALL software interfered with the educational objective of the material. On the other hand, CALL use did not appear to influence problem solving or other higher-level cognitive strategies. In addition, the ethnographer noted a tendency for students to speak highly of CALL lessons that they knew their own teacher had written (a similar result was observed in the research conducted by Lozano et al. [43]). Such students appeared to have developed a sense of ownership and pride in CALL software that was not exhibited by learners using CALL written by persons unknown to them. Blomeyer's data also indicated no particular characteristic of microcomputer technology that alone led to better gains in learning by any particular sociological grouping (sex, age, social class, value orientation). Finally, the data provide convincing evidence that language teachers must learn how to enter a whole new

technological, cultural, and political realm when they begin to implement CALL into the curriculum. The observations from this study indicate that language teachers must develop the ability to make districtwide policies work for them as they attempt to become computer-literate and to procure hardware and software, in an effort to improve their teaching. In short, they must be willing to emerge from the culture of the classroom and enter the culture of the learning center (House, 32); and they must be willing to garner computer time assertively, carefully, and convincingly for their language students.

Countless research questions become immediately apparent upon reading the Blomeyer study: What long-term effects on the quality of teaching might result from continued classroom teacher commitment to software design and programming? What types of rewards are school districts willing to make for such efforts? Do students learn more from CALL materials when the author is their own teacher? The list could go on and on. Suffice it to say, such research provides needed preliminary information for hypothesis generation that would, perhaps, never come to the attention of researchers without the use of ethnographic research methodology.

Formal Surveys

CALL basic research can take the form of formal surveys. Surveys are challenging to construct and require a considerable amount of validation prior to their use. Nevertheless, by sampling just a small percentage of CALL users, formal surveys have the potential of identifying special needs, frustrations, misconceptions, and other useful information.

Two surveys concerning CALL that have been particularly informative are those by Olsen (56) and Stolurow and Cubillos (85). Olson investigated the current or planned use of CALL in departments of foreign languages nationwide, collected the names of faculty presently using CALL, and solicited advice and comments for the neophyte teacher-user. Although Olson acknowledged that the design of the survey lent itself toward response more from CALL users than from nonusers, on a purely descriptive level the structure and content of the survey provided interesting insights and possible impetus for a future effort that would involve more formal data analysis. Results indicated that computer users tend to be enthusiastic about CALL while nonusers tend to express concerns about the dehumanizing influence of machines on language learning. Respondents who employ CALL indicated that students' attitudes toward language study generally improved, and that students learned more material faster than when they used traditional workbooks.

Stolurow and Cubillos (85) conducted a national survey of teachers, authors, administrators, distributors, and publishers to determine their

perception of needs and desired opportunities for CALL. Results indicated that the most commonly mentioned need was for more courseware. In addition, teachers expressed the desire for more quality control and improved evaluation of software, and for more effective dissemination of CALL lessons. The most commonly desired opportunity was more training, specifically in the capabilities of CALL and on how to integrate software packages into an existing curriculum. The report concludes with several recommendations of improvements in teacher training and development, in CALL software development, and in professional priorities for the medium.

Conclusion

This chapter has counseled that CALL research should be conducted vigorously, but that the research design chosen for such studies should take into account a number of factors. First, the research itself should be cost-effective; the profession needs to receive the highest possible return for time and effort. Research efforts that stand the best chance of providing explanatory data and adding to the theoretical bases for second-language learning have a greater likelihood of longevity and ecological validity. Second, it has been argued that comparative research that attempts to illustrate the superiority of computers over some other medium for delivering language instruction should forever be abandoned. Finally, encouragement should be given to evaluative research using CALL software that may be widely adopted and may enjoy an extended use over time. Such research helps to ensure a good match between user and software.

Although far too little research on CALL has been conducted, some rather clear foundational tenets are emerging that support previous research in education in general, and in second-language education specifically:

1. Meaningful (as opposed to manipulative) CALL practice is both possible (Schaeffer, 71, 72) and preferable (Pederson, 58, 59; Robinson et al., 64; Schaeffer, 71, 72).
2. The way CALL is designed to encourage the development of language learning skills can result in more learning (Johansen and Tennyson, 37; Pederson, 58, 59; Robinson et al., 64).
3. Learner differences can be documented easily and accurately through computer tally of interactive learning strategies (Jamieson, 35; Pederson, 58).
4. Learner differences can affect learner strategies, learning gains, and attitude in CALL (Chapelle and Jamieson, 11; Pederson, 59).
5. Students tend to demonstrate a more positive attitude toward CALL materials written by their own instructor (Blomeyer, 7; Lozano et al., 43).

6. Language teachers need to develop strategies for maneuvering effectively within the culture of the learning laboratory and the educational institution in order to secure needed computer resources (Blomeyer, 7).
7. Despite the enthusiasm of language teachers who are already using CALL (Olsen, 56), many language teachers are dissatisfied with existent CALL software and desire training on how to integrate CALL into the existing curriculum (Stolurow and Cubillos, 85).

In short, the research clearly indicates that CALL is highly context-bound. The nature of the learners, the task they believe they are supposed to perform, and the way the CALL materials are designed all play individual and interdependent roles in determining learning outcomes. Researchers should continue to investigate all three variables in a variety of contexts in future CALL basic studies.

While classroom teachers cannot be expected to devote their time to grassroots research, there is much they can do. First, they can become critical consumers of research reports and refuse to accept comparative research results as either valid or reliable. Second, they can lend support to basic research on CALL by providing experimenters with insights and potential research questions that emerge as they observe their students using the medium. Third, they can support appropriate research by making their students available as experimental subjects. Fourth, they can encourage more evaluative research by simply demanding such reports from software distributors before investing in major software packages. Finally, they can refuse to be carried away by the current enthusiasm for "proving" that computers are somehow "better" than some other mode of instruction. Rather, teachers should show interest and openness to experimenting with the new technology to discover how it can best benefit the learner, but they should avoid the tendency to make sweeping claims about the computer's effectiveness.

In his description of appropriate second-language research methodologies, Stern (84, p. 63) observes

> language teaching theory has had a strong preference for speculation, the expression of personal opinion, the explanation of practical experience, and participation in controversy—all perfectly legitimate ways of finding directions provided they are balanced by systematic empirical procedures. But in language teaching theory we have tended *to neglect the collection of empirical data* [emphasis added]

Jarvis (36) urges "that we must emphasize and vastly increase subject-matter-specific research knowledge" (p. 396). Such an increased interest

in disciplined, dispassionate research that attempts patiently and carefully to add to what is already known about how students learn languages is the best assurance that CALL, unlike the language lab of the 1960s, will be used intelligently.

References. Research on Computer-Assisted Language Learning

1. Abraham, Roberta G. "Field Independence–Dependence and the Teaching of Grammar." *TESOL Quarterly* 19, 4 (1985):689–702.
2. Adams, Edward N., and Peter S. Rosenbaum. *DLI–IBM Joint Feasibility Study in Computer-Assisted Foreign Language Instruction.* Final report. Monterey, CA: Defense Language Institute, 1969. [EDRS: ED 032 542.]
3. Alatis, James. "The Application of Instructional Technology to Language Learning." *CALICO Journal* 1, 1 (1983):9–12,14.
4. Arthurs, J. "The Language Lab: Cybernetics and Self-Interest." *The Canadian Modern Language Review* 36 (1979–80):38–48.
5. Barrutia, Richard. "Two Approaches to Self-Instructional Language Study: Computerized Foreign Language Instruction." *Hispania* 53 (1970):361–71.
6. Belland, John C., William D. Taylor, James Canelos, Francis Dwyer, and Patti Baker. "Is the Self-Paced Instructional Program, via Micro-Computer Based Instruction, the Most Effective Method of Addressing Individual Learning Differences?" *Educational Communications and Technology Journal* 33 (1985):185–98.
7. Blomeyer, Robert L. "The Use of Computer-Based Instruction in Foreign Language Teaching: An Ethnographically-Oriented Study." Unpublished Ph.D. dissertation. Urbana, IL: The University of Illinois, 1985.
8. Bracht, Glenn H., and Gene V. Glass. "The External Validity of Experiments." *American Educational Research Journal* 5 (1968):437–74.
9. Brebner, Ann, Ken Johnson, and Donna Mydlarski. "CAI and Second Language Learning: An Evaluation of Programs for Drill and Practice in Written French." *Computers and Education* 8 (1984):471–74.
10. British Council. *The ESP Teacher: Role, Development, and Prospects.* ELT Documents 112. London, England: British Council, 1981. [EDRS: ED 258 463.]
11. Chapelle, Carol, and Joan Jamieson. "Computer-Assisted Language Learning as a Predictor of Success in Acquiring English as a Second Language." *TESOL Quarterly* 20, 1 (1986):27–46.
12. Clark, Richard E. "Reconsidering Research on Learning from Media." *Review of Educational Research* 53 (1983):445–59.
13. Cronbach, Lee Joseph, and Richard E. Snow. *Aptitudes and Instructional Methods: A Handbook of Research on Interactions.* New York: Irvington, 1977.
14. Curtin, Constance, and Stanley Shinall. "Programing for Learning." *CALICO Journal* 1, 5 (1984):12–16.
15. Dalgish, Gerard M. "Computer-Assisted ESL Research." *CALICO Journal* 2, 2 (1984):32–37.
16. Davies, Norman F. "Foreign/Second Language Education and Technology in the Future." *NALLD Journal* 16, 3, 4 (1982):5–13.
17. Diamond, Robert M. "Instructional Development: One Biased View (Problems, Issues, and the Future)." *Educational Technology* 20, 2 (1980):51–54.
18. Dostert, Leon E. "Tradition and Innovation in Language Teaching: The Changing Times." *The Modern Language Journal* 44 (1960):220.
19. Dursky, Janice. "Comparison of a Computer Assisted Instructional Unit and a Programmed Text Format for Teaching Latin and Greek Derivatives to

Conditionally Enrolled University Students." Unpublished Ph.D. dissertation. Des Moines, IA: The Drake University, 1983.
20. Eisele, James E. "Computers and Learning: Some Needed Research." *Educational Technology* 24, 2 (1984):34–35.
21. Fought, John, Catherine Doughty, Dana Boatman, and Richard Young. "Automated Methods in Foreign Language Training and Instruction." Language Analysis Project, The University of Pennsylvania (Philadelphia), 1986.
22. Gagné, Robert M. "Is Educational Technology in Phase?" *Educational Technology* 20, 2 (1980):7–14.
23. Goodman, H. J. A. "Cognitive Mapping, Learning Styles, and Sensory Preference as Factors in Individualized Instructions: A Position Paper on the As Yet Largely Untapped Research Potential of Integrated Information Systems When Combined with Educational Technology." Paper presented at the Annual Meeting of the American Educational Research Association, Toronto, Canada, March 1978. [EDRS: ED 161 407.]
24. Haas, Werner. "The Potential and Limitation of Computer Assisted Instructions in the Teaching of Foreign Languages." Paper presented at the Annual Meeting of the American Council on the Teaching of Foreign Languages, New Orleans, November 1976. [EDRS: ED 139 269.]
25. Hocking, Elton. "How Far Have the Modern Foreign Languages Progressed since World War II?" *The Modern Language Journal* 43 (1959):168.
26. Holmes, Glyn. "The Computer and Limitations." *Foreign Language Annals* 17 (1984):413–14.
27. _____, and Marilyn E. Kidd. "Second-Language Learning and Computers." *The Canadian Modern Language Review* 38 (1981–82):503–16.
28. Hope, Geoffrey R. "Elementary French Computer-Assisted Instruction." *Foreign Language Annals* 15 (1982):347–53.
29. _____, Heimy F. Taylor, and James P. Pusack. *Using Computers in Teaching Foreign Languages*. Language and Education: Theory and Practice, no. 57. Orlando, FL: Harcourt Brace Jovanovich, 1984. [EDRS: ED 246 695.]
30. Hosenfeld, Carol G. "A Learning-Teaching View of Second-Language Instruction: The Learning Strategies of Second-Language Learners with Reading-Grammar Tasks." Unpublished Ph.D. dissertation. Columbus, OH: The Ohio State University, 1977.
31. _____. "The New Student Role: Individual Differences and Implications for Instruction," pp. 129–67 in Gilbert A. Jarvis, ed., *Perspective: A New Freedom*. The ACTFL Foreign Language Education Series. Lincolnwood, IL: National Textbook Company, 1976.
32. House, Ernest R. *The Politics of Educational Innovation*. Berkeley, CA: McCutcheon, 1974.
33. Huebener, Theodore. *Audio-Visual Techniques in Teaching Foreign Languages*. Rev. ed. New York: New York University Press, 1967.
34. Hurly, Paul, and Denis Hlynka. "Prisoners of the Cave: Can Instructional Technology Improve Education?" Paper presented at the National Conference on Instructional Technology, National Research Council of Canada, Toronto, 1982. [EDRS: ED 244 608.]
35. Jamieson, Joan. "Cognitive Styles, Working Styles on Computers and Second Language Learning." Unpublished Ph.D. dissertation. Urbana, IL: The University of Illinois, 1986.
36. Jarvis, Gilbert A. "The Psychology of Second-Language Learning: A Declaration of Independence." *The Modern Language Journal* 67 (1983):393–402.
37. Johansen, Keith J. and Robert D. Tennyson. "Effect of Adaptive Advisement Perception in Learner-Controlled, Computer-Based Instruction Using a

Rule-Learning Task." *Educational Communication and Technology* 31 (1983):226–36.
38. Keating, Raymond F. *A Study of the Effectiveness of Language Laboratories.* New York: Columbia University Teachers College, Institute of Administrative Research, 1963.
39. Koekkoek, Byron J. "The Advent of the Language Laboratory." *The Modern Language Journal* 43 (1959):4–5.
40. Kyle, Patricia J., Cathy R. Pons, and Marva A. Barnett. "Computer Lesson Design for Elementary French: A Methodological Approach," pp. 68–74 in Patricia B. Westphal, ed., *Strategies for Foreign Language Teaching: Communication, Technology, Culture.* Proceedings of the Central States Conference on the Teaching of Foreign Languages. Lincolnwood, IL: National Textbook Company, 1984.
41. Lesgold, Alan, and Frederick Reif. *Computers in Education: Realizing the Potential.* Chairman's Report of a Research Conference, Pittsburgh, Pennsylvania, November 20–24, 1982. Washington, DC: Office of Educational Research and Improvement (ED), June 1983. [EDRS: ED 235 783.]
42. Lorge, Sarah W. "Language Laboratory Research Studies in New York City High Schools: A Discussion of the Program and the Findings. *The Modern Language Journal* 48 (1964):409–19.
43. Lozano, Anthony G., Beth J. Dublinski, Terry Halwes, Ralph B. Kite, and Sharon Ludwig. *Colorado CAI Spanish Research Project.* Final Report. Boulder, CO: University of Colorado, International Research and Studies Program, 1985.
44. Mathieu, Gustave. "One Answer to Advanced Lab Work." *The Modern Language Journal* 44 (1960):352–54.
45. May, Barbara Ann. "Effective Instruction for Teaching Basic Writing Skills with Computer-Assisted Language Learning in an English as a Second Language Program." Unpublished Ph.D. dissertation. Kingsville, TX: Texas A&I University, 1984.
46. McCoy, Ingeborg H., and David M. Weible. "Foreign Languages and the New Media: The Videodisc and the Microcomputer," pp. 105–52 in Charles J. James, ed., *Practical Applications of Research in Foreign Language Teaching.* The ACTFL Foreign Language Education Series. Lincolnwood, IL: National Textbook Company, 1983.
47. McGraw, Myrtle B. "The Roles of the Teacher and the Student in the Electronic World." *The Modern Language Journal* 43 (1959):218–20.
48. Mellgren, Millie. "Applying Microcomputers in the Foreign Language Classroom: Challenges and Opportunities," pp. 74–78 in Alan Garfinkel, ed., *The Foreign Language Classroom: New Techniques.* Proceedings of the Central States Conference on the Teaching of Foreign Languages. Lincolnwood, IL: National Textbook Company, 1983.
49. Meredith, R. Alan. "Materials and Equipment: The New Generation." *The Modern Language Journal* 67 (1983):424–30.
50. Montague, William E. "Analysis of Cognitive Processes in the Specification of Interactive Instructional Presentations for Computer-Based Instruction." Paper presented at the Annual Meeting of the American Educational Research Association, New York, March 1982. [EDRS: ED 224 476.]
51. Moore, Gary W. *Developing and Evaluating Educational Research.* Boston: Little, Brown, 1983.
52. Morrison, H. W., and E. N. Adams. "Pilot Study of a CAI Laboratory in German." *The Modern Language Journal* 52 (1968): 279–87.
53. Mueller, Gunther A. "Visual Contextual Cues and Listening Comprehension: An Experiment." *The Modern Language Journal* 64 (1980):335–40.

54. Mustard, Helen, and Anthony Tudisco. "The Foreign Language Laboratory in Colleges and Universities: A Partial Survey of Its Instructional Use." *The Modern Language Journal* 43 (1959):332–40.
55. O'Brien, George M. "Siren Songs and a Skeptic." Paper presented at the International Conference on Computers and the Humanities, Los Angeles, April 1985. [EDRS: ED 104 163.]
56. Olsen, Solveig. "Foreign Language Departments and Computer-Assisted Instruction: A Survey." *The Modern Language Journal* 64 (1980):341–49.
57. Omaggio, Alice C. "Pictures and Second Language Comprehension: Do They Help?" *Foreign Language Annals* 12 (1979):107–16.
58. Pederson, Kathleen Marshall. "The Effects of Passage Availability during Adjunct Questioning in Computer-Assisted Reading Practice on Recall Measures of Reading Comprehension in Intermediate College French." Unpublished Ph.D. dissertation. Columbus, OH: The Ohio State University, 1985.
59. _____. "An Experiment in Computer-Assisted Second-Language Reading." *The Modern Language Journal* 70, 1 (1986):36–41.
60. Post, Nancy E. "Microcomputers and Language Training." *Journal of Educational Technology Systems* 11 (1983):277–83.
61. Putnam, Constance E. "Foreign Language Instructional Technology: The State of the Art." *CALICO Journal* 1, 1 (1983):35–41.
62. Ragsdale, Ronald G. "The Computer Threat to Educational Technology." Paper presented at the Annual Meeting of the Association for Educational Communications and Technology, Research and Theory Division, Dallas, 1982. [EDRS: ED 223 231.]
63. Rivers, Wilga M. "Understanding the Learner in the Language Laboratory." *NALLD Journal* 16, 2 (1982):5–13.
64. Robinson, Gail, John Underwood, Wilga Rivers, José Hernández, Carollyn Rudesill, and Clare Malnik Enseñat. "Computer-Assisted Instruction in Foreign Language Education: A Comparison of the Effectiveness of Different Methodologies and Different Forms of Error Correction." San Francisco: Center for Language & Crosscultural Skills, 1985. [EDRS: ED 262 626.]
65. Salomon, Gavriel. "Media and Symbol Systems as Related to Cognition and Learning." *Journal of Educational Psychology* 71 (1979):131–48.
66. _____. "What Is Learned and How It Is Taught: The Interaction between Media, Message, Task, and Learner," pp. 383–406 in David R. Olson, ed., *Media and Symbols: The Forms of Expression, Communication, and Education.* 73rd Yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press, 1974.
67. _____. "Internalization of Filmic Schematic Operations in Interaction with Learners' Aptitudes." *Journal of Educational Research* 66 (1974):499–511.
68. _____. *Interaction of Media, Cognition, and Learning.* Washington, DC: Jossey-Bass, 1979.
69. _____, and Richard E. Clark. "Reexamining the Methodology of Research on Media and Technology in Education." *Review of Educational Research* 47 (1979):99–120.
70. Scanlan, Richard T. "Computer-Assisted Instruction in Latin." *Foreign Language Annals* 13 (1982):53–55.
71. Schaeffer, Reiner H. "Computer-Supplemented Structural Drill Practice versus Computer-Supplemented Semantic Drill Practice by Beginning College German Students: A Comparative Experiment." Unpublished Ph.D. dissertation. Columbus, OH: The Ohio State University, 1979.
72. _____. "Meaningful Practice on the Computer: Is It Possible?" *Foreign Language Annals* 14 (1981):33–37.
73. Scherer, George, and Michael Wertheimer. *A Psycholinguistic Experiment in*

Foreign Language Teaching. New York: McGraw-Hill, 1964.
74. Schramm, Wilbur. *Big Media, Little Media*. Beverly Hills, CA: Sage Publications, 1977.
75. Schrupp, David M., Michael D. Bush, and Gunther A. Mueller. "*Klavier in Haus*: An Interactive Experiment in Foreign Language Instruction," *CALICO Journal* 1, 1 (1983):17–21.
76. Siciliano, Ernest A. "Language Laboratories Develop the Listening Ear." *The Modern Language Journal* 43 (1959):224–25.
77. Simonsen, Sofus E. "Student Approach and Reaction to CAI: An Analysis of Evaluations and Logs." *CALICO Journal* 3, 2 (1985):35–39.
78. Smith, Philip D. and Emanuel Berger. *An Assessment of Three Foreign Language Teaching Strategies Utilizing Three Language Laboratory Systems*. Washington, DC: U.S. Office of Education, 1968.
79. Smith, R. Lorne. "Some Considerations That Seem to Weigh against the Use of Tape Recordings in the Language Laboratory." *The Modern Language Journal* 44 (1960):75–76.
80. Smith, Wm. Flint. Language Learning Laboratory," pp. 191–237 in Dale L. Lange, ed., *Encyclopaedia Britannica Review of Foreign Language Education*, vol. 2. Chicago: Encyclopaedia Britannica, 1972.
81. Spitzer, Dean R., and James P. Kielt. "Technology Assessment: An Antidote for Murphy's Law." *Educational Technology* 17, 7 (1977):20–23.
82. Stack, Edward M. *The Language Laboratory and Modern Language Teaching*. 3rd. ed. New York: Oxford University Press, 1971.
83. Steffin, Sherwin A. "A Suggested Model for Establishing the Validity of Computer-Assisted Instructional Materials." *Educational Technology* 23, 1 (1983):20–22.
84. Stern, H. H. *Fundamental Concepts of Language Teaching*. Toronto: Oxford University Press, 1983.
85. Stolurow, Lawrence, and Enrique M. Cubillos. *Needs and Development Opportunities for Educational Software for Foreign Language Instruction in Schools*. Iowa City, IA: Center for Educational Experimentation, Development, and Evaluation, University of Iowa, June 1983. [EDRS: ED 242 204.]
86. Taylor, Heimtraut F. "Students' Reactions to Computer Assisted Instruction in German." *Foreign Language Annals* 12 (1979):289–91.
87. Teichert, Herman U. "Computer Assisted Instruction in Beginning College German: An Experiment." *CALICO Journal* 3, 2 (1985):18–24.
88. Terry, Robert A. "MONIQUE: The Assistante." Paper presented at the Annual Foreign Language Conference sponsored by the Division of Secondary Education, Richmond, VA, October 1978. [EDRS: ED 145 725.]
89. Underwood, John H. *Linguistics, Computers, and the Language Teacher: A Communicative Approach*. Rowley, MA: Newbury House, 1984.
90. Williams, Roger. "Design, Development, and Testing of Five Computer-Assisted Instruction Lessons in French Grammar. Unpublished Ph.D. dissertation. Athens, GA: The University of Georgia, 1980.
91. Wyatt, David H. *Computers and ESL*. Language and Education: Theory and Practice. no. 56. Orlando, FL: Harcourt Brace Jovanovich, 1984. [EDRS: ED 246 694.]
92. Young, Biloine. "A Do-It-Yourself Language Lab." *The Modern Language Journal* 43 (1959):221–23.